

CLAIMS

What is claimed is:

- 1 1. A packaging structure comprising at least one semiconductor device bonded to a
2 chip carrier or heat spreader with an adhesive, wherein the adhesive is reworkable and
3 thermally conductive and comprises a cured reaction product from a diepoxide and cyclic
4 anhydride wherein the epoxy groups are connected through an acyclic acetal moiety; and
5 a thermally conductive filler.
- 1 2. The packaging structure of claim 1 wherein the diepoxide is a cycloaliphatic
2 diepoxide.
- 1 3. The packaging structure of claim 1 wherein the diepoxide is selected from the
2 group consisting of acetaldehyde bis (3,4-epoxycyclohexylmethyl) acetal, acetone bis-
3 (3,4-epoxycyclohexylmethyl) ketal, and formaldehyde bis-)4,4-epoxycyclohexylmethyl)
4 acetal.
- 1 4. The packaging structure of claim 1 where the diepoxide is acetaldehyde bis- (3,4-
2 epoxycyclohexylmethyl) acetal.
- 1 5. The packaging structure of claim 1 wherein the filler is non-electrically
2 conductive.
- 1 6. The packaging structure of claim 1 wherein the filler is selected from the group
2 consisting of silver flake, aluminum nitride and silica-coated aluminum nitride.
- 1 7. The packaging structure of claim 1 wherein the filler is aluminum nitride or silica-
2 coated aluminum nitride.

1 8. The packaging structure of claim 1 where the adhesive further comprises a
2 thixotropic agent.

1 9. The packaging structure of claim 1 wherein the filler is electrically conductive.

1 10. The packaging structure of claim 1 where the thixotropic agent comprises silica or
2 siloxane-coated fumed silica.

1 11. The packaging structure of claim 10 wherein (a) the amount of diepoxide is about
2 10 to about 30% by weight, (b) the amount of cyclic anhydride is about 10 to about 30%
3 by weight, (c) the amount of filler is about 40% to about 79% by weight and (d)
4 thixotropic agent about 0.05 to about 2% by weight, the amounts being based on the
5 total of (a), (b), (c) and (d) in the composition.

1 12. The packaging structure of claim 1 wherein the adhesive provides a void-free
2 bond.

1 13. The packaging structure of claim 1 wherein the at least one semiconductor device
2 is bonded to a chip carrier and is electrically connected to the chip carrier with
3 wirebonds.

1 14. The packaging structure of claim 1 wherein the at least one semiconductor device
2 is a flip chip and the flip chip is bonded to the heat spreader.

1 15. The packaging structure of claim 14 which further comprises an underfill
2 encapsulant.

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1 16. A method for fabricating a packaging structure which comprises bonding at least
2 one semiconductor device to a chip carrier by applying a composition comprises a
3 diepoxide wherein the epoxy groups are connected through an acyclic acetal moiety, a
4 cyclic anhydride and a thermally conductive filler; and curing the composition to provide
5 a reworkable and thermally conductive adhesive.

1 17. The method of claim 16 wherein the diepoxide is a cycloaliphatic diepoxide.

1 18. The method of claim 16 wherein the diepoxide is selected from the group
2 consisting of acetaldehyde bis- (3,4-epoxycyclohexylmethyl) acetal, acetone bis- (3,4-
3 epoxycyclohexylmethyl) ketal, and formaldehyde bis- (3,4-epoxycyclohexylmethyl)
4 acetal.

1 19. The method of claim 16 where the diepoxide is acetaldehyde bis- (3,4-
2 epoxycyclohexylmethyl) acetal.

1 20. The method of claim 16 wherein the filler is non-electrically conductive.

1 21. The method of claim 16 wherein the filler is selected from the group consisting of
2 silver flake, aluminum nitride and silica-coated aluminum nitride.

1 22. The method of claim 16 wherein the filler is aluminum nitride or silica-coated
2 aluminum nitride.

1 23. The method of claim 16 wherein the adhesive further comprises a thixotropic
2 agent.

1 24. The method of claim 16 wherein the thixotropic agent comprises silica or
2 siloxane-coated formed silica.

1 25. The method of claim 24 wherein a) the amount of diepoxide is about 10 to about
2 30% by weight, b) the amount of cyclic anhydride is about 10 to about 30% by weight,
3 c) the amount of filler is about 40 to about 79% by weight and c) thixotropic agent is
4 about .05 to about 2% by weight, the amount being based upon the total of a), b), c) and d)
5 in the composition.

1 26. The method of claim 16 wherein the at least one semiconductor device is
2 electrically connected to the chip carrier with wirebonds after curing of the composition.

1 27. The method of claim 16 wherein the at least one semiconductor device is a flip
2 chip and wherein the flip chip is bonded to a heat spreader.

1 28. A reworkable thermally conductive adhesive composition comprising a) about 20
2 to about 60% by weight of a cured reaction product from diepoxide and a cyclic
3 anhydride wherein the epoxy groups are connected through an acyclic acetal moiety b)
4 about 40 to about 79% by weight of a thermally conductive filler; c) about 0.05 to about
5 2% by weight of a thixotropic agent based upon the total a), b), and c) in the composition.

1 29. The composition of claim 28 wherein the diepoxide is a cycloaliphatic diepoxide.

1 30. The composition of claim 28 wherein the diepoxide is selected from the group
 2 consisting of acetaldehyde bis- (3,4 -epoxycyclohexyl) acetal, acetone bis- (3,4-
 3 epoxycyclohexylmethyl) ketal, and formaldehyde bis- (3,4- epoxycyclohexylmethyl)
 4 acetal.

1 31. The composition of claims 28 wherein the diepoxide is acetaldehyde bis- (3,4 -
 2 epoxycyclohexylmethyl) acetal.

1 32. The composition of claim 28 wherein the filler is non-electrically conductive.

1 33. The composition of claim 28 wherein the filler is selected from the group
 2 consisting of silver flake, aluminum nitride and silica-coated aluminum nitride.

1 34. The composition of claim 28 wherein the filler is aluminum nitride or silica-
 2 coated aluminum nitride.

1 35. The composition of claim 28 wherein the thixotropic agent comprises silica or
 2 siloxane-coated firmed silica.